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BORING'S MACH AND STATE VARIABLES

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Staddon cites Boring's (1950) *History of Experimental Psychology* as an influential source of information about the views of Ernst Mach. This is what Boring said about Mach:

> His [Mach's] most important work . . . was his *Analyse der Empfindungen* (1886). . . . In this book Mach established what might be called early modern positivism. . . . Mach's positivism was his reduction of all the phenomena of both physics and psychology to the immediate data of their observation, to "sensations," as he said. (pp. 383–395)

In Boring's treatment, Mach's views were important for psychology because they provided a powerful rationale for the introspective psychologies developed by Titchener and Külpe, which held sensation to be the fundamental analytic unit. "Like Wundt with his immediate and mediate experience, Mach justified introspection by establishing the observational status of conscious data beyond a doubt" (p. 394). Indeed, notes Boring, as Titchener was developing his introspective psychology, he "seized especially upon Mach and was ever after greatly influenced by him" (pp. 399–400). Boring's interest in the development of Titchener's views is understandable. Boring was a student and disciple of Titchener, to whom he dedicated his *History*.

Staddon's interest is in commenting on Mach's well-established influence on Skinner and the tradition of the experimental analysis of behavior. His citation of Boring thus offers a rather remarkable, ironic juxtaposition: Apparently Mach provided the intellectual foundation both for structural introspective psychology (Titchener) and for functional behaviorism (Skinner). The resolution of this apparent paradox is, of course, that the two traditions emphasized different aspects of Mach's views. The various significant commonalities, and sources of influence, among the views of Mach, Loeb, Crozier, and Skinner are amply and effectively developed by Marr (1985), Pauly (1987), and Smith (1986). Boring's treatment would not be helpful if one wanted to understand better the relation between Mach's and Skinner's views.

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State Variables

Staddon makes an important point about the circumstances favoring the development of *state* concepts. He notes that states can be especially useful conceptual (or summarizing) devices when different histories (independent variables) have equivalent effects.

Skinner made what appears to be a similar argument in favor of conceptualizing *drive* and *emotion* as states. In the first chapter of *The Behavior of Organisms* (1938), he wrote:

> The operations characterizing drive and emotion differ from the others listed in that they effect concurrent changes in *groups* of reflexes. The operation of feeding, for example, brings about changes in all the operants that have been reinforced with food and in all the conditioned and unconditioned respondents concerned with ingestion. Moreover, a single operation is not unique in its effect. There is more than one way of changing the strength of the group of reflexes varying with ingestion or with an emotional stimulus. In addition to the formulation of the effect upon a single reflex, we must deal also with the drive or the emotion as the "state" of a group of reflexes. This is done by introducing a hypothetical middle term between the operation and the resulting observed change. "Hunger," "fear," and so on, are terms of this sort. The operation of feeding is said to affect the hunger and the hunger in turn the strength of the reflex. The notion of an intermediate state is valuable when (a) more than one reflex is affected by the operation, and (b) when several operations have the same effect. (p. 24)

Later in the book Skinner elaborated on these views:

> The preceding formulation of drive may be summarized as follows. In measuring the strength of a drive we are in reality only measuring strength of behavior. A complete account

> of the latter is to be obtained from an examination of the operations that are found to affect it. The "drive" is a hypothetical state interpolated between operation and behavior and is not actually required in a descriptive system. The concept is useful, however, as a device for expressing the complex relation that obtains between various similarly effective operations and a group of co-varying forms of behavior. The properties assigned to the state are derived from the observations of these relations. (p. 368)

Several points are notable. First, in both passages Skinner, like Staddon, stresses that state concepts can be useful when different operations are equivalent in their effects. Second, Skinner notes that states—regarded as summarizing devices for expressing the relation between sets of independent and dependent variables—are "not actually required in a descriptive system" (p. 368). Staddon makes a similar point in noting the intertranslatability between organism-based and environment-based accounts, provided the functional relations between independent and dependent variables have, indeed, been established. Thus, there seems to be agreement that state concepts are not necessary, although they can be helpful under some circumstances.

Although Skinner made early use of state concepts, it is well known that his views regarding such concepts became rather more negative in his later writings, mostly for practical reasons. All too often, he observed, state-like terms are invoked as causes in the absence of clear linkages to independent variables that would permit prediction and control. Because state concepts were not necessary, it seemed prudent to avoid using them, thereby reducing the chances of being seduced into using them inappropriately. Staddon seems to agree that state concepts are of dubious value, at best, unless they are clearly derived from demonstrated functional relations between environmental independent variables and behavioral dependent variables.

> Any environment-based theory can be rephrased as an organism-based theory, although the converse is not true. A valid criticism of some cognitive theories is that states are postulated without any clear specification of the historical data necessary to identify them. (p. 446)

In short, Staddon seems to agree with Skinner on what state variables are and on the circumstances under which they may be helpful, but also on the fact that they are unnecessary in a functional analysis and on their potential dangers. Where they differ is on the weights they give to the potential benefits and costs. Skinner, especially in his writings after the mid-1950s, tended to stress the risks arising from the seductive power of organism-based theorizing. Hineline's (1990, 1992) analysis of organism-based versus environment-based interpretive language within our culture offers principled support for Skinner's concern (see also Watkins, 1990). Staddon, in contrast, thinks we can be disciplined enough to enjoy the benefits of state concepts without undue risk. He suggests that the field has matured, and that the language of mathematics can help impose necessary discipline.

Indirectly, then, Staddon seems to be inviting us to revisit Skinner's early work on the logic and use of state variables. Meehl (1992) has recently made the invitation explicit:

> The *locus classicus* for Skinner on state-variables is *The Behavior of Organisms* (pp. 22–25). I doubt that anyone has ever set out such a clear, concise, and compelling rationale for introducing them. One thesis of this paper is that the later Skinner never rebutted these powerful arguments in favor of motivational variables. (p. 413)

Before accepting the invitation, I would like to be sure of a couple of points and so ask the following questions of Staddon: Is your view of state variables—their status, their potential value, and their potential dangers—indeed like Skinner's, as I have suggested? Or have I ignored or blurred an important area of disagreement? Does your emphasis on equivalent histories change the character of the argument or does it represent an application to a new problem?

How prevalent within the experimental analysis of behavior is the kind of state-variable theorizing that you favor? I get the sense that you think it is very rare. Does the concept of *behavioral momentum,* as developed by Nevin and his associates (e.g., Nevin, Mandell, & Atak, 1983), fall within this class of theories? Does Skinner's use of *response strength* fit the conception? Are there other examples?

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